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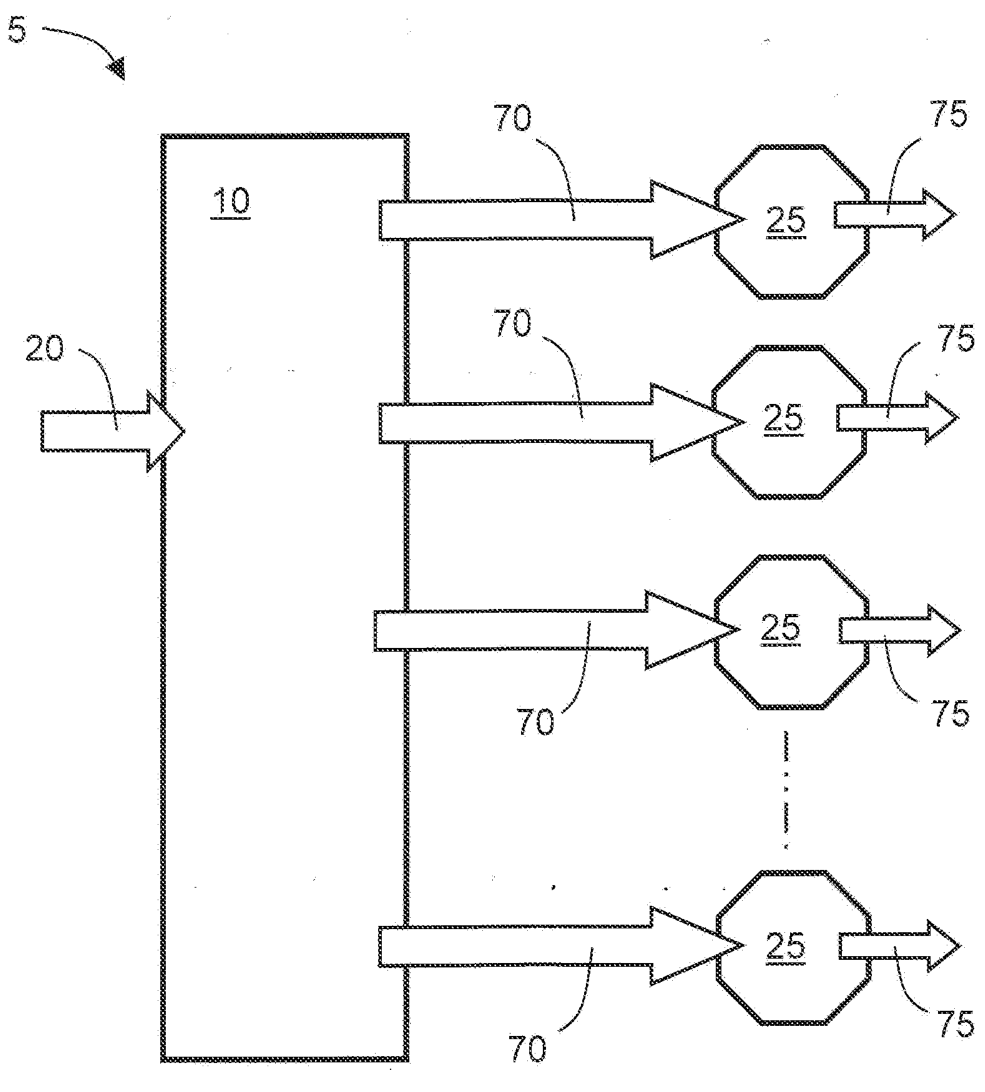

FIG. 1

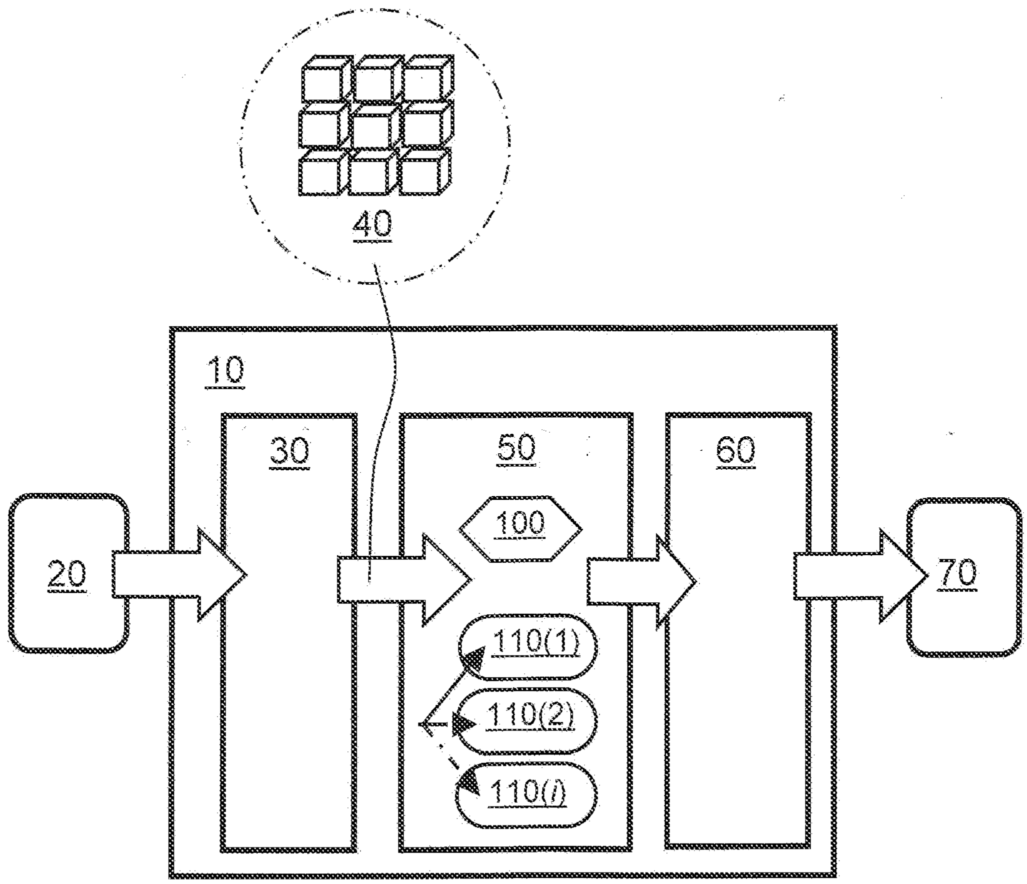

FIG. 2A

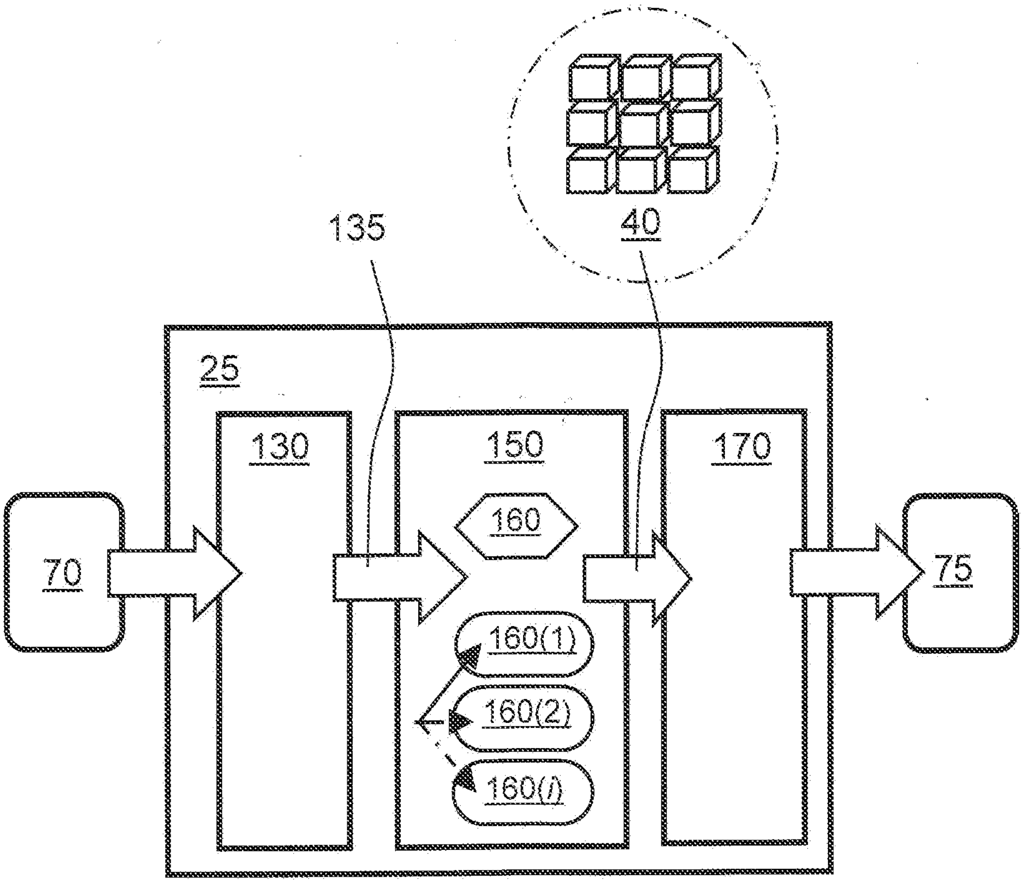

FIG. 2B

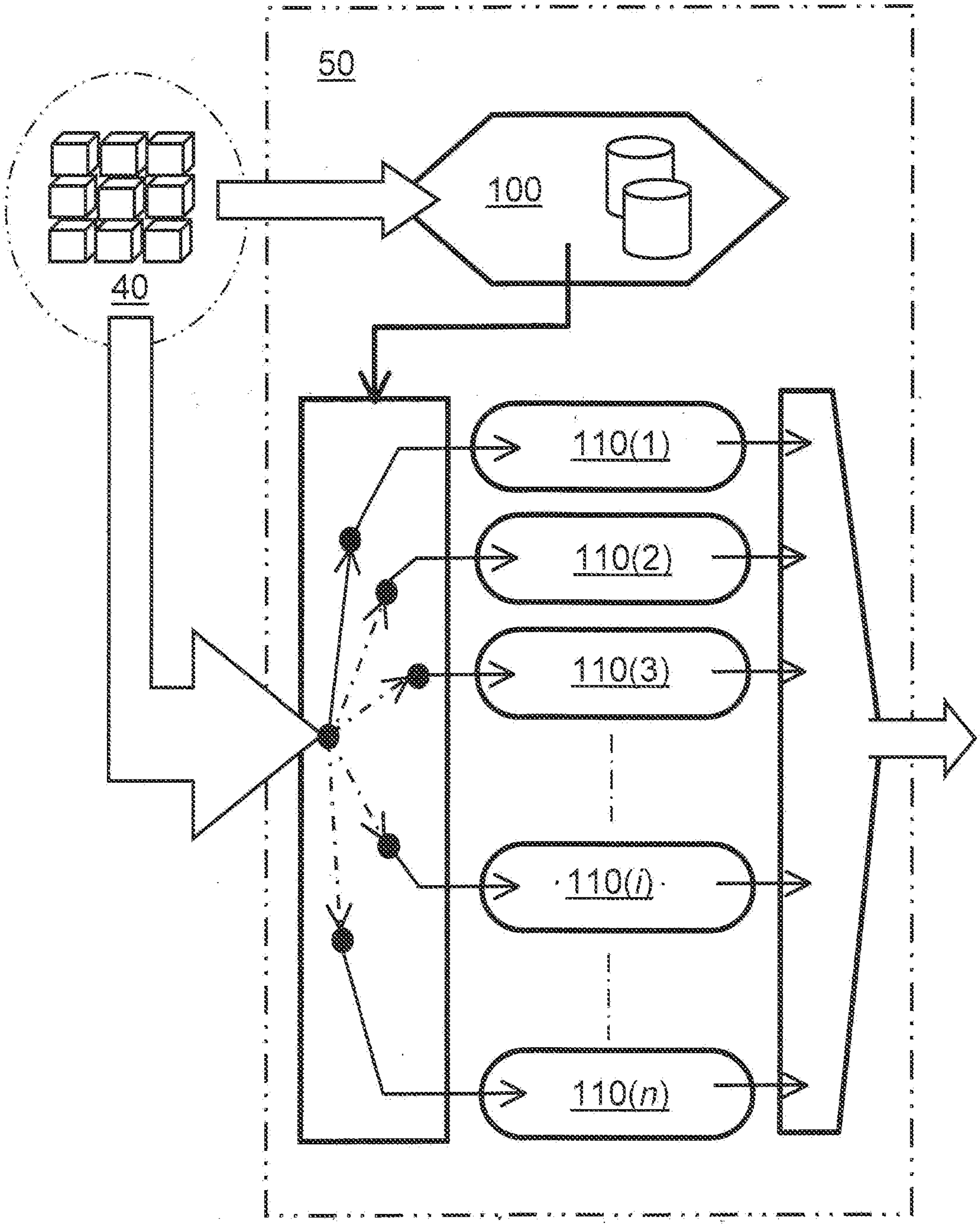

FIG. 3

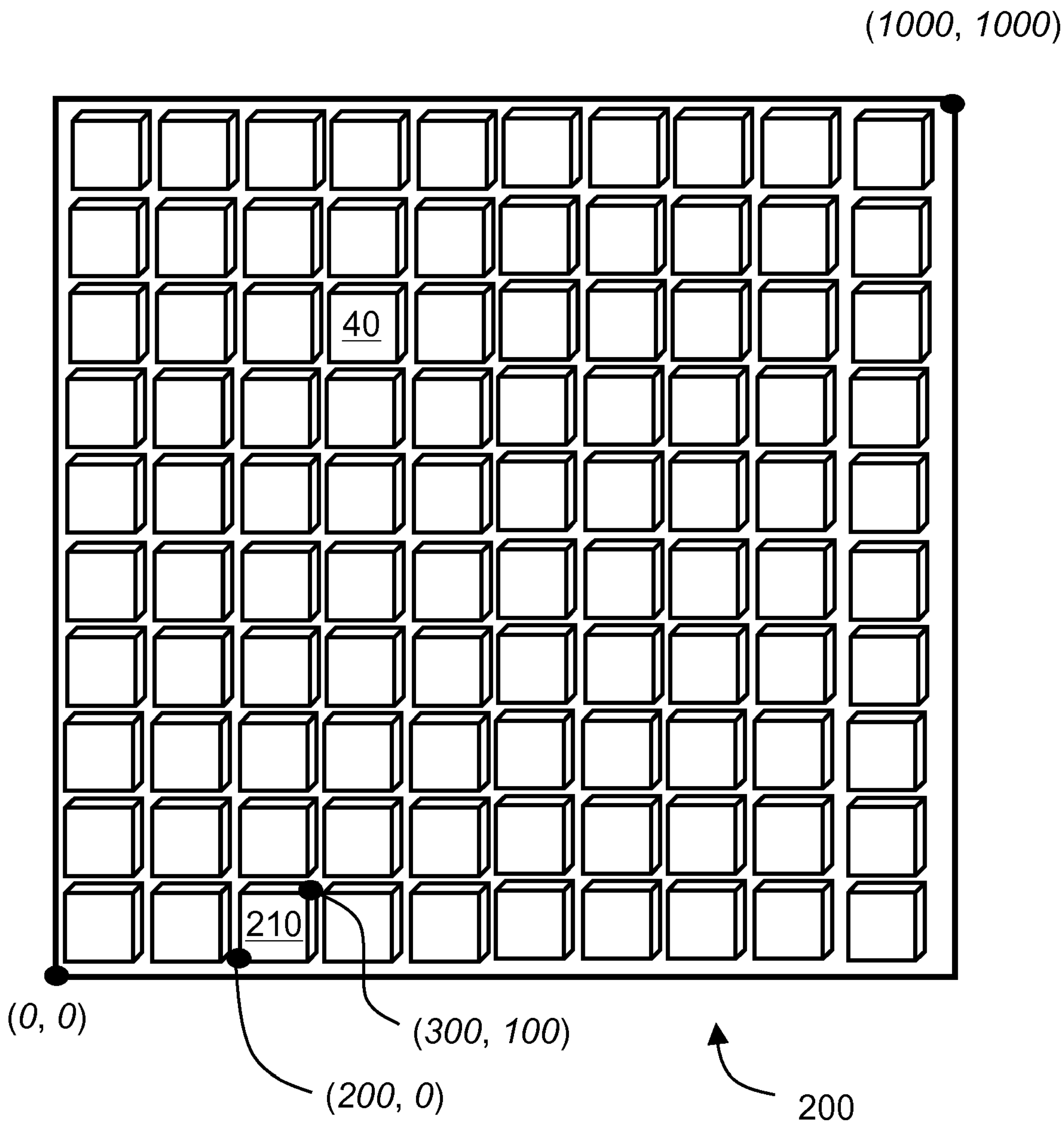

FIG. 4

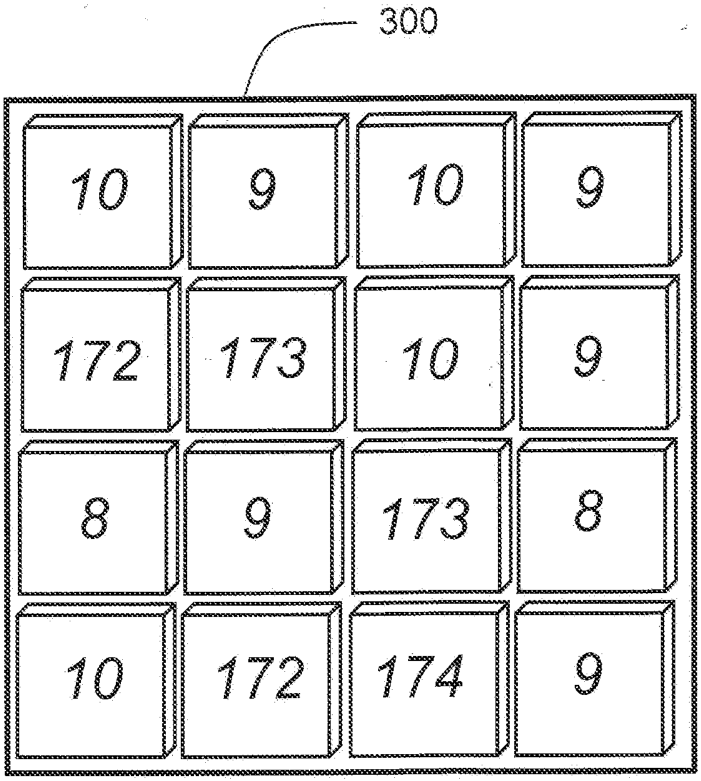

FIG. 5

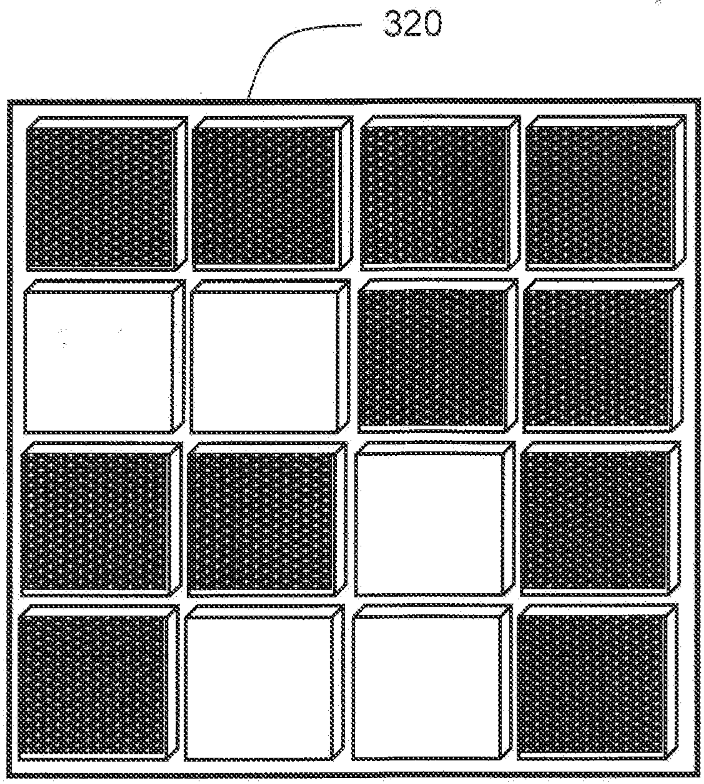

FIG. 6

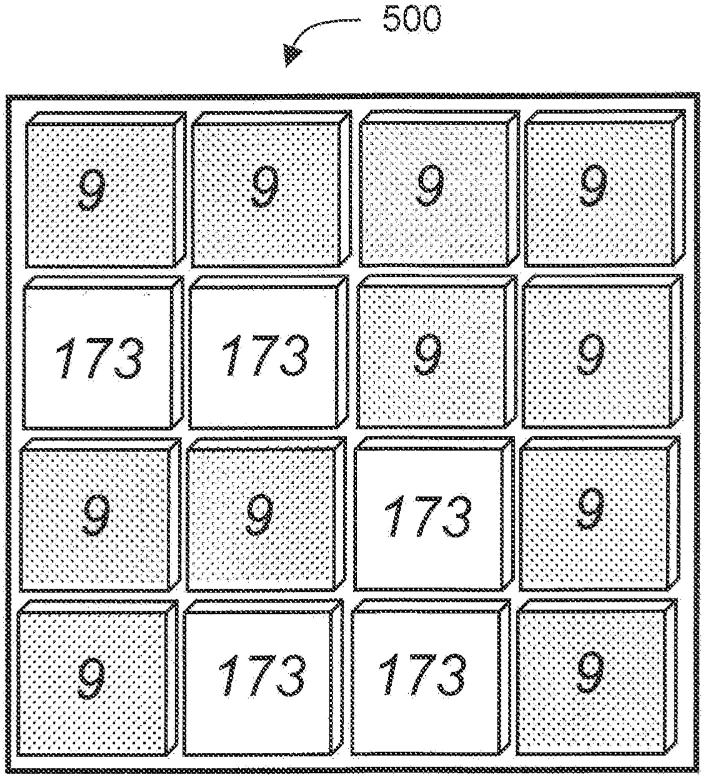

FIG. 7

ENCODER, DECODER AND METHOD

Field of the invention

The present invention relates to encoders for encoding data corresponding to a variety of content, for example still images, video content, graphics content, audio content, measurement data and so forth, for generating corresponding encoded output data. Moreover, the present invention concerns methods of encoding data corresponding to a variety of content, for example still images, video content, graphics content, audio content, measurement data and so forth, for generating corresponding encoded output data. Furthermore, the present invention relates to decoders for decoding data in an encoded format generated by the aforesaid encoders. Additionally, the present invention is concerned with methods of decoding data generated by aforesaid encoders. Yet additionally, the present invention relates to software products recorded on machine-readable data storage media, wherein the software products are executable upon computing hardware for implementing aforementioned methods.

Background of the invention

There are many contemporary known methods of encoding data, and also decoding the encoded data. Nevertheless, there is a lack of a method of encoding data which is suitable for a broad range of content represented by the data to be encoded, for example still images, video content, audio content or graphics data. Such encoding has as its primary aim to generate encoded output data which is more compact than corresponding input data to be encoded. Moreover, there is also a lack of a corresponding decoder for decoding such encoded data.

Image encoding methods such as *JPEG* (“Joint Photographic Experts Group”, namely lossy DCT-based coding, wherein “DCT” is an abbreviation for Discrete Cosine Transform), *JPEG2000* (“Joint Photographic Experts Group”, namely wavelet-based encoding) and *WebP* (image format encoding which employs both lossy and lossless compression during encoding) are known to be well adapted for compressing natural image content, but are less suitable for compressing text or images whose colours are described by only a few colour values and whose content has a relatively high spatial frequency component. An alternative known method of encoding data is referred to as *GIF* ("Graphics Interchange Format") and employs a palette-based compression algorithm which is well adapted to encode images that can be presented with a relative small number of colour values required to render the images, for example 256 colour values; however, if the images to be encoded by *GIF* algorithms include natural objects having subtle spatially-gradual colour variations, *GIF* creates undesirable artefacts which are noticeable in corresponding decoded *GIF* images. Known contemporary *PNG* encoding ("Portable Networks Graphics", lossless encoding) is generally similar to *GIF* encoding and provides more options for encoding image data, but is not nevertheless well adapted for images which contain a small range of colour values. Other known encoding methods employ text encoding using *OCR* ("Optical Character Recognition") in combination with encoding characters; OCR is sometimes an appropriate method to employ, but is sensitive to positioning of text within an image, tilting of text within the image, a font of the text and also an object in which the text is located; additionally, OCR can potentially require considerable processing power for its implementation.

More recently, scientific publications have proposed yet alternative encoding methods which are suitable for encoding data which is in a bi-level block data sequence format; details of these scientific publications are provided in Table 1.

Table 1: Encoding methods for encoding data in bi-level block data sequence format.

Title of publication	Authors	Publication details
"A bi-level block coding technique for encoding data sequences with sparse distribution"	Li Tan and Jean Jiang	Proceedings of the 2008 IAJC-IJME International Conference, International Journal of Modern Engineering (IJME), paper 185, ENT 201. ISBN 978-1-60643-379-9
"Lossless compression of waveform data for efficient transmission and storage"	S.D. Stearms, L. Tan, and N. Magotra	IEEE Transactions on Geoscience and Remote Sensing, Vol. 31, no. 3, pp 645-654, May 1993

"A block coding technique for encoding sparse binary patterns"	G. Zeng and N. Ahmed	IEEE Transactions on Acoustics, Speech and Signal Processing, Vol. 37, no. 5, pp 778-780, May 1989

Aforesaid known methods of encoding data, and corresponding known methods of decoding such encoded data, are not well adapted for a broad range of content represented by the data, despite the known methods employing a wide range of mutually different approaches. Despite considerable research over many years to evolve more efficient encoding algorithms to provide improved data compression, namely an issue of great importance to communication systems handling streamed video content, an optimal encoding method has yet to be devised.

Summary of the invention

The present invention seeks to provide an improved method of encoding input data to generate corresponding encoded output data, for example encoded output data which is compressed relative to its corresponding input data.

The present invention also seeks to provide an encoder which employs an improved method of encoding input data to generate corresponding encoded output data, for example encoded output data which is compressed relative to its corresponding input data.

The present invention seeks to provide an improved method of decoding data generated from encoders pursuant to the present invention.

The present invention seeks to provide an improved decoder for decoding data generated from encoders pursuant to the present invention.

According to a first aspect of the present invention, there is provided an encoder as claimed in appended claim 1: there is provided an encoder for encoding input data to generate corresponding encoded output data, characterized in that the encoder includes an analysis unit for analysing one or more portions of the input data and directing the one or more portions to appropriate one or more encoding units depending upon a nature of content included in the one or more portions, wherein the one or more portions are selected in size as a function of the nature of the content included in the one or more portions, wherein the one or more encoding units are operable to encode the one or more portions thereat to generate the encoded output data, wherein at least one of the one or more encoding units is operable to compute an average value of data values present in each portion received thereat, to subdivide the data values into at least two sets, to compute average values of the data values in each set, and for each set to allocate the average value for that set to all data values in that set, whilst retaining a spatial mask of the portion, and wherein the spatial mask and information representative of the average values computed for the at least two data sets are included in the encoded output data.

The present invention is of advantage in that the encoder is operable to compute averages of sets and masks defining layouts of portions of the input data for inclusion in output encoded data from the encoder which provides for efficient encoding of certain types of content present in the input data.

Optionally, the encoder includes an output encoder unit for receiving encoded output data from the one or more encoding units and for further encoding this encoded output data to generate the encoded output data from the encoder.

Optionally, the encoder further includes an input stage for partitioning the input data to one or more portions when the input data is not already subdivided into one or more portions.

Optionally, in the encoder, the average value is at least one of: an arithmetic average, a skewed average, a logarithmic average, a weighted average.

Optionally, in the encoder, the at least one of the one or more encoding units is operable to subdivide the data values present in each portion into a range of 2 to 8 data sets, or into 2 or more data sets. A portion corresponds to a data block of an image, for example. For example, 8 data sets are optionally used for 8-bit binary data.

Optionally, the encoder is operable to store information representative of the one or more masks of the one or more portions in a remote database for access by one or more decoders when decoding the encoded output data generated by the encoder.

According to a second aspect of the invention, there is provided a method of encoding input data to generate corresponding encoded output data, characterized in that the method includes

(a) using an analysis unit for analysing one or more portions of the input data and directing the one or more portions to appropriate one or more encoding units, depending upon a nature of content included in the one or more portions, wherein the one or more portions are selected in size as a function of the nature of the content included in the one or more portions, wherein the one or more encoding units are operable to encode the one or more portions thereat to generate the encoded output data; and

(b) using at least one of the one or more encoding units to compute an average value of data values present in each portion received thereat, to subdivide the data values into at least two sets, to compute average values of the data values in each set, and for each set to allocate the average value for that set to all data values in that set, whilst retaining a spatial mask of the portion, and wherein the spatial mask and information representative of the average values computed for the at least two data sets are included in the encoded output data.

Optionally, the method includes using an output encoder unit for receiving encoded output data from the one or more encoding units and for further encoding this encoded output data to generate the encoded output data.

Optionally, the method includes employing an input stage for partitioning the input data to one or more portions when the input data is not already subdivided into one or more portions.

Optionally, in the method, the average value is at least one of: an arithmetic average, a skewed average, a logarithmic average, a weighted average.

Optionally, the method includes using at least one of the one or more encoding units to subdivide the data values present in each portion into a range of 2 to 8 data sets.

Optionally, the method includes storing information representative the one or more masks of the one or more portions in a remote database for access by one or more decoders when decoding the encoded output data.

According to a third aspect of the invention, there is provided a decoder for decoding encoded input data to generate corresponding decoded output data, characterized in that the decoder includes

an analysis unit for analysing one or more portions of the input data and directing the one or more portions to appropriate one or more decoding units depending upon a nature of content included in the one or more portions, wherein the one or more portions are selected in size as a function of the nature of the content included in the one or more portions, wherein the one or more decoding units are operable to decode the one or more portions thereat for generating the decoded output data, wherein

at least one of the one or more decoding units is operable to extract a spatial mask and information representative of average values computed for at least two data sets included in the encoded input data, and for assigning average values to elements in the mask pursuant to which of the sets the elements belong as defined by the mask.

Optionally, the decoder includes an output decoder unit for receiving decoded output data from the one or more decoding units and for further decoding this encoded output data to generate the decoded output data from the decoder.

Optionally, the decoder further includes an input stage for extracting from the encoded input data one or more portions for directing as defined by encoding parameters present in the encoded input data to one or more decoding units.

Optionally, the decoder is implemented such that the average value is at least one of: an arithmetic average, a skewed average, a logarithmic average, a weighted average. Other types of average are also possible.

Optionally, the decoder is implemented such that the at least one of the one or more decoding units is operable to assign average values to elements of the mask corresponding the data sets, wherein there are in a range of 2 to 8 data sets, or to 2 or more data sets. For example, 8 data sets are optionally used for 8-bit binary data

Optionally, the decoder is operable to retrieve information representative the one or more masks of the one or more portions from a remote database when decoding the encoded input data generated by an encoder.

According to a fourth aspect of the invention, there is provided a method of decoding encoded input data to generate corresponding decoded output data, characterized in that the method includes

(a) using an analysis unit for analysing one or more portions of the encoded input data and directing the one or more portions to appropriate one or more decoding units depending upon a nature of content included in the one or more portions, wherein the one or more portions are selected in size as a function of the nature of the content included in the one or more portions, wherein the one or more decoding units are operable to decode the one or more portions thereat for generating the decoded output data; and

(b) using at least one of the one or more decoding units to extract a spatial mask and information representative of average values computed for at least two data sets included in the encoded input data, and to assign average values to elements in the mask pursuant to which of the sets the elements belong as defined by the mask.

Optionally, the method includes using an output decoder unit for receiving decoded output data from the one or more decoding units and for further decoding this encoded output data to generate the decoded output data.

Optionally, the method further includes using an input stage for extracting from the encoded input data one or more portions for directing as defined by encoding parameters present in the encoded input data to one or more decoding units.

Optionally, when using the method, the average value is at least one of: an arithmetic average, a skewed average, a logarithmic average, a weighted average.

Optionally, when using the method, the at least one of the one or more decoding units is operable to assign average values to elements of the mask corresponding the data sets, wherein there are in a range of 2 to 8 data sets, or to 2 or more data sets. Such an example is beneficially used for 8-bit binary data, although further 16-bit, 32-bit and so forth binary data is optionally used.

Optionally, the method includes retrieving information representative the one or more masks of the one or more portions from a remote database when decoding the encoded input data generated by an encoder.

According to a sixth aspect of the invention, there is provided a data communication system including at least one encoder pursuant to the first aspect of the invention for encoding input data and generating corresponding encoded data, and including at least one decoder pursuant to the third aspect of the invention for decoding the encoded data to generate decoded output data.

According to a seventh aspect of the invention, there is provided a method of communicating data in a data communication system pursuant to the sixth aspect of the invention, wherein the method of communicating data utilizes a combination of a method pursuant to the second aspect of the invention, and a method pursuant to the fourth aspect of the invention.

According to a seventh aspect of the invention, there is provided a software product recorded on machine-readable data storage media, characterized in that the software product is executable upon computing hardware for executing a method pursuant to the second aspect of the invention.

According to an eighth aspect of the invention, there is provided a software product recorded on machine-readable data storage media, characterized in that the software product is executable upon computing hardware for executing a method pursuant to the fourth aspect of the invention.

It will be appreciated that features of the invention are susceptible to being combined in various combinations without departing from the scope of the invention as defined by the appended claims.

Description of the diagrams

Embodiments of the present invention will now be described, by way of example only, with reference to the following diagrams wherein:

FIG. 1 is an illustration of an encoder and a decoder pursuant to the present invention;

FIG. 2A is a schematic illustration of an encoder for implementing a method of encoding input data pursuant to the present invention;

FIG. 2B is a schematic illustration of a decoder for implementing a method of decoding input data which has been encoded pursuant to the present invention;

FIG. 3 is a schematic illustration of a second encoding stage of the encoder of FIG. 2A;

FIG. 4 is an illustration of subdividing image data into data blocks, namely portions, for encoding in the second encoding stage of the encoder of FIG. 2A;

FIG. 5 is an illustration of a data block to be encoded using the encoder of FIG. 2A;

FIG. 6 is an illustration of a mask for the data block of FIG. 5, after computation of average values for sets of levels employed to represent the data block of FIG. 5; and

FIG. 7 is an illustration of a regenerated decoded data block derived from encoded data generated by the encoder of FIG. 2A.

In the accompanying diagrams, an underlined number is employed to represent an item over which the underlined number is positioned or an item to which the underlined number is adjacent. A non-underlined number relates to an item identified by a line linking the non-underlined number to the item. When a number is non-underlined and accompanied by an associated arrow, the non-underlined number is used to identify a general item at which the arrow is pointing.

Description of embodiments of the invention

In overview, the present invention is concerned with an improved method of encoding input data to generate corresponding encoded output data, wherein the method is capable of providing an enhanced degree of coding efficiency. The improved method is capable of efficiently coding a wide range of content represented in the input data, for example still images, video content, graphics content, audio content, *ECG* ("electrocardiogram"), seismic data and so forth.

Referring to FIG. 1, there is provided an illustration of an encoder **10** which is operable to encode input data **20** using a method pursuant to the present invention. The encoder **10** generates encoded output data **70** which can be stored and/or streamed for subsequent decoding at one or more decoders **25**. The one or more decoders **25** are operable to generate corresponding decoded data **75** for consumption by one or more users. The decoded data **75** corresponds substantially to the input data **20**. A combination of at least one encode **10** and at least one corresponding decoder **25** forms a data communication system indicated generally by **5**.

Referring to FIG. 2A, there is provided an illustration of the encoder **10** which is operable to encode the input data **20** using a method pursuant to the present invention. The encoder **10** employs a first stage **30** which partitions the input data **20** into data blocks **40**, if the input data **20** is not already in a data block format. In a second stage **50**, the encoder **10** processes each data block **40** and sorts its data into at least two levels as well as generating a mask describing which data values in the data block **40** belong to which corresponding level, as well as computing mean values of the data sorted into each level. The mask is beneficially implemented as a spatial bit map. In a third stage **60** involves compressing the bitmap as well as the mean values for each level to generate encoded output data **70** from the encoder **10**; different compression algorithms are optionally employed for the third stage **60**, for example *RLE* ("Run-length encoding"), *DPCM* ("Differential pulse-code modulation"), *VLC* ("Variable-length coding"). Optionally, the encoder **10** can be employed in combination with other encoders for achieving hybrid encoding of the input data **20** to generate encoded output data **70**, for example *DCT*, *palette*, *DPCM*. In practice, the term "level" can correspond to one or more of: a chrominance level, a luminance level, a colour value, a brightness, an amplitude, a frequency, an intensity; however, "level" can also include other parameters describing physical variables depending upon a nature of the input data **20**.

In the first stage **30**, the data blocks **40** can vary in size, depending upon a nature of content present in the input data **20**. The input data **20** is optionally 1-dimensional, for example audio content, *ECG-data (Electrocardiography)*, seismic data. Alternatively, the input data **20** is multi-dimensional, for example still images, video content, graphics content, 3D image/video/graphics. Moreover, 2-dimensional input data includes, for example, square, triangle, circle, and similar elements, namely optionally any form of 2-dimensional geometrical shape. Furthermore, 3-dimensional image data includes, for example, elements which are cubic, pyramid, cylinder, ball-shaped, and so forth. When the input data **20** includes spatially high frequency components and only a few levels to define spatial elements represented in the input data **20**, contemporary known encoding methods are especially ineffective, but are processed efficiently in the encoder **10**. Optionally, the encoder **10** is capable of encoding the input data **20** as original data or formed by way of pre-encoding processing, for example *DPCM*, *motion estimation*, *spatial prediction*.

In the second stage **50** of the encoder **10**, a compression method pursuant to the present invention is employed as illustrated in FIG. 3. Data blocks **40** from the first stage **30** are analyzed in an analysis unit **100** to determined a most appropriate encoding algorithm to employ for encoding the data blocks **40**; depending upon the analysis executed by the analysis unit **100**, the data blocks are directed to one or more encoding units **110(1)** to **110(*n*)**, wherein *n* is an integer and describes a total number of different coding algorithms employed within the second stage **50**. The analysis unit **100** analyses a number of different colours present in the data blocks **40** and spatial frequency information present in the data blocks **40** for purposes of deciding which encoding unit **110** is optimal to employ for encoding a given type of data block **40**. The encoding units **110** optionally employ one or more of: DC ("*Direct Current*") encoding, slide encoding, DCT ("*discrete cosine transform*"), wavelet encoding, palette encoding database encoding, VQ ("*vector quantization*") encoding. In encoded output data from the second stage **50**, there is included data indicative of which of the encoder units **110** have been employed for any given data block **40**. At least one encoding unit **110(*i*)** of the encoding units **110**, wherein an integer i is in a range 1 to n, employs a coding algorithm pursuant to the present invention which will be described in more detail later. Optionally, sizes of the data blocks **40** can vary in a data stream provided from the first stage **30**, wherein information provided to the second stage **50** also includes information which is spatially indicative of where the data blocks **40** are included in any one or more given images; such information is included in encoded output data provided from the second stage **50**; such inclusion of data-block position indicative data is beneficially implemented as described in United Kingdom patent application no. GB1214414.2 (encoder) and US patent application no. 13/584, 047 (decoder), these applications being hereby incorporated by reference. Alternatively, such inclusion is beneficially implemented in the third stage **60**. Sizes of the data-blocks can be presented with numbers such as *height* x *width* expressed in pixels. Spatial positions of the data-blocks are beneficially defined as co-ordinates relative to the image such as x, y pixels from a corner of the image.

Referring to FIG. 2B, the decoder **25** corresponding to the encoder **10** is shown. The decoder **25** includes a first decoding stage **130** which is operable to receive the encoded data **70** and to execute upon the encoded data **70** an inverse of encoding applied by third stage **60** of the encoder **10** for generate intermediate decoded data denoted by **135**. The intermediate decoded data includes information such as which type of encoding unit **110** was employed to encode a given data block **40**, mask for the data block **40**, average value where appropriate, and so forth. The decoder **25** further includes a second stage **150** which includes one or more decoder units **160** corresponding to an inverse of the encoder units **110**, wherein encoded data blocks present in the intermediate decoded data **135** are directed to appropriate decoder units **160** included in the second stage to regenerate the data blocks **40** within the decoder **25**. The decoder **25** further includes a third stage **170** which is operable to apply an inverse of operations performed in the first stage **30** of the encoder **10**, for generating the decoded output data **75** corresponding substantially to the input data **20**. Additionally, or alternatively, spatial and size information of data blocks **40** are optionally generated in a first decoding stage **130**. The spatial and position information is beneficially further sent to the second stage **150** in order to enable the third stage **170** to place data blocks in appropriate spatial position.

The encoding algorithm pursuant to the present invention is susceptible to being employed to encode data blocks **40** of any size, although it is beneficially employed for encoding data blocks **40** including in a range of 8 to 256 elements or values, for example pixels. Moreover, the coding algorithm is conveniently referred to as being a *multilevel coding method*. A first and most useful implementation of the algorithm employs two levels, for example colours although not limited thereto as aforementioned, and is optimized to encode subject matter such as code command prompts, text and other content that include only two levels. However, it is optionally feasible to implement the algorithm to encode more than two levels; beneficially, the number of levels into which data blocks are encoded is beneficially considerably less than a number of levels present in the data blocks **40** prior to being encoded, for example beneficially at least 3 times less, more beneficially at least 5 times less, and yet more beneficially at least 10 times less. The number of levels present in the data blocks prior to being encoded in the second stage **50** is referred to as being the *original number of levels*, namely is a measure of dynamic levels present in the data blocks **40**, for example representative of image-, video-, audio- or graphics-content. For example, referring to FIG. 4, an image field **200** includes 1000 x 1000 pixels points in a 2-dimensional array, wherein the image field **200** is subdivided in the first stage **30** of the encoder **10** into 100 data blocks **40**, denoted by **210**, wherein each block **210** corresponds to 100 x 100 pixels, namely 10, 000 pixels in total. Each pixel is represented in colour and/or intensity by 8 binary bits defining 256 levels of dynamic range. When the encoding unit **110(*i*)** encodes a given block **210**, the number of levels is reduced, for example, in a range of 2 to 8, together with supplementary data as will be described later. In a event that the encoding unit **110(*i*)** employs more than, for example, 8 levels, the encoding unit **110(*i*)** becomes less efficient at providing data compression, requiring use of pre-processing of the image **200**, for example predictive coding or delta coding, prior to data being presented to the second stage **50**.

The encoding algorithm employed in the encoding unit **110(*i*)** is optionally employed for encoding a greyscale image or other information that only uses one channel. Moreover, the encoding algorithm employed in the encoding unit **110(*i*)** is optionally employed for colour images or other multichannel content. Multichannel content, for example 3-D colour images, are optionally encoded so that all the channels are compressed similarly, or alternatively are optionally encoded in mutually different manners, for example data blocks of audio channels are optionally encoded in a different manner to data blocks of video channels. In an event that the channels are encoded in a mutually different manner, different coding algorithms in the encoder units **110** and different sizes of the data blocks **40** can be employed; the selection of data block **40** sizes is, as aforementioned, optionally implemented on a basis of type of content present in the input data **20**.

The encoding algorithm employed in the encoding unit **110(*i*)** will now be described in greater detail with reference to FIG. 5. In FIG. 5, an example original data block **40** is denoted by **300**. The data block **300** includes 4 x 4 pixels having greyscale values as shown. Beneficially, the data block **300** is susceptible to being encoded efficiently in the encoding unit **110(*i*)** using an algorithm pursuant to the present invention, with a small coding error occurring during encoding.

When applying the algorithm, a mean value for all pixels or elements in the block **300** is computed in computing hardware or dedicated digital hardware of the encoder **10**:

$$\text{MeanAll} = \frac{(10+9+10+9+172+173+10+9+8+9+173+8+10+172+174+9)}{16} =$$

$$\frac{965}{16} = 60.3125$$

Next, the algorithm defines two sets of levels, namely Level_0 and Level_1, wherein the set Level_0 includes all pixels whose values are below MeanAll, and the set Level_1 includes all pixels whose values are equal to or above MeanAll. The pixels of the data block **300** are then mapped onto a corresponding data block **320** in FIG. 6, wherein spatial locations of the pixels are retained but they are now represented by merely two levels corresponding to the sets Level_0 and Level_1. For each of the sets of levels, namely Level_0 and Level_1, mean values are computed in the aforesaid computing hardware or dedicated digital hardware:

$$\text{MeanLevel\_0} = \frac{(10+9+10+9+10+9+8+9+8+10+9)}{11} = \frac{101}{11} = 9.1818\ldots$$

$$\text{MeanLevel\_1} = \frac{(172+173+173+172+174)}{5} = \frac{864}{5} = 172.8$$

Thereafter, when executing the algorithm, a spatial representation of the pixels in the data block **320** is stored as a pixel mask, together with mean values for each of the sets of levels, namely MeanLevel_0 and MeanLevel_1; alternatively, instead of storing in data memory, such data is streamed from the encoder unit **110(*i*)**. Although a geometric mean computation is described in the foregoing for the algorithm, it will be appreciated that other types of averaging summation computation are possible, for example a skewed mean, an asymmetrical mean, a logarithmic mean. Optionally, the values for each of the set of levels can be calculated using any calculating means, for example dedicated digital hardware and/or a computing device executing software products. From a point of view of the decoder, a method of calculation employed is not a key issue. Optional examples of computing means include “brute force” methods, Monte Carlo methods and so forth, to find optimum number of levels and values for the set of levels. Example optimization can be Rate-Distortion optimization to determine how many bits should be used during coding and how much error is allowed for the coded information. Instead of outputting from the algorithm, one mean value is optionally output from a reference one of the sets, and a difference value for the other set relative to the reference set, for example 9.1818 and (172.8 - 9.1818). Optionally, the mean values as computed above are quantized, for example to nearest integer values, in order to obtain a higher degree of data compression in output data from the encoder unit **110(*i*)**. Optionally, a degree of quantization employed is a dynamic function of how many sets are required to represent the data block **300**. Quantization to nearest integer for the example above provides MeanLevel_0 = 9, and MeanLevel_1 = 173.

When generating output data from the encoder unit **110(*i*)**, a spatial representation of the pixels, namely a mask, is output, based upon the data block **320**, in a plurality of potential scanning orders, for example left-to-right and top-to-bottom as illustrated in FIG. 6, in a zig-zag manner, maze or similar. In an example, the mask is output left-to-right and top-to-bottom such that mask is expressed in output data from the encoder unit **110(*i*)** as 0000 1100 0010 0110.

When the encoder **10** is employed to encode video content, a sequence of images is presented to the encoder **10**, wherein each image is susceptible to being broken down into data blocks **40** which are then encoded using the encoder units **110** as appropriate depending upon their content. Beneficially, as aforementioned, the encoder **10** switches dynamically between the different encoder units **110** depending upon a nature of data blocks presented to the second stage **50** for encoding. The choice of encoder units **110** is, as aforementioned, recorded in the encoded output data from the second stage **50**. The third stage **60** optionally applies further encoding and/or compression, for example using one or more of DPCM ("*differential pulse-code modulation*"), RLE ("*run-length encoding*"), arithmetic coding, delta coding, VLC ("*Variable-length coding*"), Lempel-Ziv coding methods (such as ZLIB, LZO, LZSS, LZ77), Burrow-Wheeler transform based coding methods (such as RLE, BZIP2) and Huffman coding. Delivery of the mask, namely scanning order for data output from the second stage **50**, is beneficially implemented via a database, for example as described in a United States patent application no. US2010/0322301 ("Image processor, image generator and computer program", Applicant - Gurulogic Microsystems Oy, Inventor – Tuomas Kärkkäinen) which is hereby incorporated by reference. Use of such a database for providing a path by which the mask is communicated to a corresponding decoder is capable of providing a form of access key, for example for hindering unauthorized distribution of encoded content in encoded form (i.e. unauthorized file sharing).

A regenerated decoded version of the data block **300** of FIG. 5 is illustrated in FIG. 7 and indicated by **500**. This regenerated data block **500** corresponds to a portion of the decoded output data **75** provided from the decoder **25**. It will be appreciated that only minor loss of information present in the data block **500** occurs relative to the original data block **40**, **300** which is input to the encoder **10**.

The encoder **10** and/or or decoder **25** are beneficially implemented using dedicated electronic hardware, for example a custom digital integrated circuit, a field-programmable gate array (*FPGA*) or similar. Alternatively, or additionally, the encoder **10** and/or the decoder **25** can be implemented by executing one or more software products, stored on machine-readable data storage media, on computing hardware coupled in data communication with data memory. Optionally, the computing hardware is implemented as a high-speed reduced-instruction-set (RISC) processor. The encoded output data **70** is optionally one or more of: streamed, stored on a data carrier such as an optically-readable disc, stored in data memory and so forth.

Modifications to embodiments of the invention described in the foregoing are possible without departing from the scope of the invention as defined by the accompanying claims. Expressions such as “including”, “comprising”, “incorporating”, “consisting of”, “have”, “is” used to describe and claim the present invention are intended to be construed in a non-exclusive manner, namely allowing for items, components or elements not explicitly described also to be present. Reference to the singular is also to be construed to relate to the plural. Numerals included within parentheses in the accompanying claims are intended to assist understanding of the claims and should not be construed in any way to limit subject matter claimed by these claims.

CLAIMS

We claim:

1. An encoder (10) for encoding input data (20) to generate corresponding encoded output data (70), characterized in that the encoder (10) includes

an analysis unit (100) for analysing one or more portions (40) of the input data (20) and directing the one or more portions (40) to appropriate one or more encoding units (110) depending upon a nature of content included in the one or more portions (40), wherein the one or more portions are selected in size as a function of the nature of the content included in the one or more portions, wherein the one or more encoding units (110) are operable to encode the one or more portions (40) thereat to generate the encoded output data (70), wherein

at least one (110(*i*)) of the one or more encoding units (110) is operable to compute an average value of data values present in each portion (40) received thereat, to subdivide the data values into at least two sets, to compute average values of the data values in each set, and for each set to allocate the average value for that set to all data values in that set, whilst retaining a spatial mask (320) of the portion (40), and wherein the spatial mask (320) and information representative of the average values computed for the at least two data sets is included in the encoded output data (70).

2. An encoder (10) as claimed in claim 1, characterized in that the encoder (10) includes an output encoder unit (60) for receiving encoded output data from the one or more encoding units (110) and for further encoding this encoded output data to generate the encoded output data (70) from the encoder (10).

3. An encoder (10) as claimed in claim 1 or 2, characterized in that the encoder (10) further includes an input stage (30) for partitioning the input data (20) into one or more portions (40) when the input data (20) is not already subdivided into one or more portions (40).

4. An encoder (10) as claimed in claim 1, 2 or 3, characterized in that the value is at least one of: an average, an arithmetic average, a skewed average, a logarithmic average, a weighted average

5. An encoder (10) as claimed in any one of the preceding claims, characterized in that the at least one (110(*i*)) of the one or more encoding units (110) is operable to subdivide the data values present in each portion (40) into a range of 2 to 8 data sets, or 2 or more data sets.

6. An encoder (10) as claimed in any one of the preceding claims, characterized in that the encoder (10) is operable to store information representative of the one or more masks (320) of the one or more portions in a remote database for access by one or more decoders when decoding the encoded output data (70) generated by the encoder (10).

7. A method of encoding input data (20) to generate corresponding encoded output data (70), characterized in that the method includes

(a) using an analysis unit (100) for analysing one or more portions (40) of the input data (20) and directing the one or more portions (40) to appropriate one or more encoding units (110) depending upon a nature of content included in the one or more portions (40), wherein the one or more portions are selected in size as a function of the nature of the content included in the one or more portions, wherein the one or more encoding units (110) are operable to encode the one or more portions (40) thereat to generate the encoded output data (70); and

(b) using at least one (110(*i*)) of the one or more encoding units (110) to compute an average of data values present in each portion (40) received thereat, to subdivide the data values into at least two sets, to compute average values of the data values in each set, and for each set to allocate the average value for that set to all data values in that set, whilst retaining a spatial mask (320) of the portion (40), and wherein the spatial mask (320) and information representative of the average values computed for the at least two data sets is included in the encoded output data (70).

8. A method as claimed in claim 7, characterized in that the method includes using an output encoder unit (60) for receiving encoded output data from the one or more encoding units (110) and for further encoding this encoded output data to generate the encoded output data (70).

9. A method as claimed in claim 7 or 8, characterized in that the method includes employing an input stage (30) for partitioning the input data (20) into one or more portions (40) when the input data (20) is not already subdivided into one or more portions (40).

10. A method as claimed in claim 7, 8 or 9, characterized in that the value is at least one of: an average, an arithmetic average, a skewed average, a logarithmic average, weighted average.

11. A method as claimed in any one or claims 7 to 10, characterized in that the method includes using at least one (110(*i*)) of the one or more encoding units (110) to subdivide the data values present in each portion (40) into a range of 2 to 8 data sets, or 2 or more data sets.

12. A method as claimed in any one or claims 7 to 11, characterized in that the method includes storing information representative the one or more masks (320) of the one or more portions in a remote database for access by one or more decoders when decoding the encoded output data (70).

13. A method as claimed in any one of claims 7 to 12, characterized in that the encoded output data is further encoded and/or compressed.

14. A method as claimed in claim 13, characterized in that the further encoding and/or compression includes at least one of: DPCM ("*differential pulse-code modulation*"), RLE ("*run-length encoding*"), arithmetic encoding, delta, coding, VLC

("*Variable-Length Coding*"), Lempel-Ziv coding (ZLIB, LZO, LZSS, LZ77), Burrow-Wheeler transform-based coding (RLE, BZIP2), Huffman coding.

15. A decoder (25) for decoding encoded input data (70) to generate corresponding decoded output data (75), characterized in that the decoder (25) includes

an analysis unit (130) for analysing one or more portions (40) of the input data (20) and directing the one or more portions (40) to appropriate one or more decoding units (160) depending upon a nature of content included in the one or more portions (40), wherein the one or more portions are selected in size as a function of the nature of the content included in the one or more portions, wherein the one or more decoding units (160) are operable to decode the one or more portions (40) thereat for generating the decoded output data (75), wherein

at least one (160(*i*)) of the one or more decoding units (160) is operable to extract a spatial mask (320) and information representative of average values for at least two data sets included in the encoded input data (70), and for assigning average values to elements in the mask (320) pursuant to which of the sets the elements belong as defined by the mask (320).

16. A decoder (25) as claimed in claim 15, characterized in that the decoder (25) includes an output decoder unit (170) for receiving decoded output data from the one or more decoding units (160) and for further decoding this encoded output data to generate the decoded output data (75) from the decoder (25).

17. A decoder (25) as claimed in claim 15 or 16, characterized in that the decoder (25) further includes an input stage (130) for extracting from the encoded input data (70) one or more portions for directing as defined by encoding parameters present in the encoded input data (70) to one or more decoding units (160).

18. A decoder (25) as claimed in any one of claims 15 to 17, characterized in that the at least one (160(*i*)) of the one or more decoding units (160) is operable to assign

values to elements of the mask (320) corresponding the data sets, wherein there are in a range of 2 to 8 data sets, or 2 or more data sets.

19. A decoder (25) as claimed in any one of claims 15 to 18, characterized in that the decoder (25) is operable to retrieve information representative of the one or more masks (320) of the one or more portions from a remote database when decoding the encoded input data (70) generated by an encoder (10).

20. A method of decoding encoded input data (70) to generate corresponding decoded output data (75), characterized in that the method includes

(a) using an analysis unit (130) for analysing one or more portions (40) of the encoded input data (70) and directing the one or more portions (40) to appropriate one or more decoding units (160) depending upon a nature of content included in the one or more portions (40), wherein the one or more portions are selected in size as a function of the nature of the content included in the one or more portions, wherein the one or more decoding units (160) are operable to decode the one or more portions (40) thereat for generating the decoded output data (75); and

(b) using at least one (160(*i*)) of the one or more decoding units (160) to extract a spatial mask (320) and information representative of average values computed for at least two data sets included in the encoded input data (70), and to assign average values to elements in the mask (320) pursuant to which of the sets the elements belong as defined by the mask (320).

21. A method as claimed in claim 20, characterized in that the method includes using an output decoder unit (170) for receiving decoded output data from the one or more decoding units (160) and for further decoding this encoded output data to generate the decoded output data (75).

22. A method as claimed in claim 20 or 21, characterized in that the method further includes using an input stage (130) for extracting from the encoded input data

(70) one or more portions for directing as defined by encoding parameters present in the encoded input data (70) to one or more decoding units (160).

23. A method as claimed in any one of claims 20 to 22, characterized in that the at least one (160(*i*)) of the one or more decoding units (160) is operable to assign values to elements of the mask (320) corresponding the data sets, wherein there are in a range of 2 to 8 data sets, or 2 or more data sets.

24. A method as claimed in any one of claims 20 to 23, characterized in that the method includes retrieving information representative the one or more masks (320) of the one or more portions from a remote database when decoding the encoded input data (70) generated by an encoder (10).

25. A data communication system (5) including at least one encoder (10) as claimed in claim 1 for encoding input data (20) and generating corresponding encoded data (70), and including at least one decoder (25) as claimed in claim 15 for decoding the encoded data (70) to generate decoded output data (75).

26. A method of communicating data in a data communication system (5) as claimed in claim 25, wherein the method of communicating data utilizes a combination of a method as claimed in claim 7, and a method as claimed in claim 20.

27. A software product recorded on machine-readable data storage media, characterized in that the software product is executable upon computing hardware for executing a method as claimed in any one of claims 7 to 14.

28. A software product recorded on machine-readable data storage media, characterized in that the software product is executable upon computing hardware for executing a method as claimed in any one of claims 20 to 24.